SPECIFICATION

To All Whom It May Concern:

Be It Known That We, Isidore I. Lamke, Robert D. Plummer, Michael E. Dinan, Eugene P. Reinhold, John Figura and Matt Narzinski, citizens of the United States of America, whose respective post office addresses are 415 Cedar Street, Washington, Missouri 63090, 2507 Tamarack Lane, St. Clair, Missouri 63084, 1346 Bald Hill Road, Leslie, Missouri 63056, 2941 Barrett Station Road, Kirkwood, Missouri 63122, 288 Boone County Lane, Defiance, Missouri 63341 and 4130 Malus Drive, St. Louis, Missouri 63125 and have invented certain new and useful improvements in

LED LAMP ASSEMBLY

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Patent Application Serial No. 10/003,845 filed November 1, 2001, which is a continuation-in-part of U.S. Patent Application Serial No. 09/126,296 filed March 9, 2000, the contents of such applications are expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION

This invention relates generally to lamps, and more specifically to vehicle lamps having an array of light emitting-diodes (LEDs) providing the light, and a structure and method of construction that produces a light structure that is relatively unbreakable and water resistant and/or water proof. While the invention is described in particular with its application in and to boat or other similar towed trailers, those skilled in the art will recognize the wider applicability of the inventive principles disclosed hereinafter.

One of the problems we have observed with respect to taillights of various boat trailers and other towed trailers for example, and with respect to vehicle lights in general, is the fact that the lights often become damaged. That is, it is not uncommon for a person who does not routinely tow a boat trailer, to experience problems in backing the boat trailer, for example. Often in backing, the taillight of the trailer becomes damaged. Likewise, boat trailers often are backed into water in order to load or unload a boat to be carried by the trailer. Because prior art light assemblies are not waterproof, water entering the light assembly can and often does damage the electrical capabilities of the light. We have developed a relatively low-cost, water proof/resistant and relatively

unbreakable back up and/or taillight and/or turning light, for example, that has wide application for vehicles, both driven and towed. In particular, we have found that a lamp assembly can be molded completely from a suitable cellulosic, copolymer, polycarbonate, or acrylic plastic, and inserted in place of conventional taillights on trailers and vehicles, for example. Preferably, we employ light emitting diodes (LEDs) as the source of illumination for the light structure. The LEDs are mounted to a circuit card or board (i.e. printed circuit board) in any predetermined arrangement. The board and associated LEDs then are completely encapsulated or immersed in the material to form a solid, effectively one-piece device during the manufacturing process.

While other lamp assemblies have employed LEDs in the past, the products of which we are aware did not provide a light structure that is relatively unbreakable alone or water proof/resistance in combination with the structure's other features. For purposes of this specification, relatively unbreakable means unbreakable in the environment of the lamp assembly's intended use during expected or normal operating conditions. For example, we have found that TENITE® available from Eastman Chemical Company is an acceptable material for the lamp assembly of the present invention where the lamp assembly is intended for use in boat trailers. While the material mix employed for injunction molding may vary for the application illustratively described herein, we believe that the material preferably should have an impact resistance of 4.8 ft-lbs. per inch (ten percent (10%) plasticizer formulation). In boat trailer applications, the material thickness may approach one half inch or more, for example, a thickness

for which we were unable to find actual manufacturer's data. We have tested other polycarbonate material in prototype assemblies that has sustained 30 ft. lbs. force on the light assembly without damage (tested by dropping a five pound weight from a height of six feet). As indicated above, the preferred material for any particular application is one that does not suffer damage in its intended application during normal or intended operation of that application.

Among the devices of which we are aware that employ LEDs is one described in United States Patent No. 5,632,551 ('551). While employing LEDs generically, the '551 patent describes the use of a conventional lens and an associated metal housing. While recognizing that breakage is a problem, the '551 patent attempts to solve the problem by recessing the lens member within the housing. While the invention described in the '551 may function well in some circumstances, it does not provide the simplified solid structure, water proof/resistant construction and true non-breakable design for light assemblies available with our invention.

BRIEF SUMMARY OF THE INVENTION

One of the objects of this invention is to provide a low-cost lamp assembly.

Another of object of this invention is to provide a lamp assembly that is relatively unbreakable in applicational use.

Another object of this invention is to provide a lamp or light structure employing LEDs for the light source.

Another object of this invention is to provide an LED lamp structure in which the LEDs are arranged in rows and columns, the arrangement of which permits LEDs emitting various visible light colors to be employed in the light structure.

Yet another object of this invention is to provide a lamp structure that is directly replaceable with existing applications for similar lamps assemblies.

Another object of this invention is to provide a lamp structure that exhibits at least water resistance capabilities for preventing damage to electrical components of the structure.

Another object of this invention is to provide a lamp or light structure employing reflectors.

Another object of this invention is to provide a circuit board which allows air to escape during the molding process.

Another object of this invention is to provide a solid structure lamp assembly.

Other objects will be apparent to those skilled in the art in light of the following description and accompanying drawings.

In accordance with this invention, generally stated, an unbreakable lamp finding particular application in automotive vehicle and trailers for example, is provided in which the lamp body defines the lens and the body itself. Preferably, the lens and body is constructed from an unbreakable material, unbreakable being defined herein. The lamp includes a circuit board or card having a light unit associated with it. In the preferred embodiment, the light unit is a plurality of

LEDs arranged in rows and columns. The lens and body material forms a structure which fully encapsulates in a solid integral part both the light unit and the circuit board. Encapsulation provides at least water resistant properties to the lamp assembly. The lens material is molded in a predetermined manner to provide the body for the lamp assembly.

A method of constructing a lamp assembly in which the lens material defines a lamp body also is disclosed.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The objects of the invention are achieved as set forth in the illustrative embodiments shown in the drawings, which form a part of the specification. In the drawings,

Figure 1 is view in perspective, partly broken away, of one illustrative embodiment of lamp assembly of the present invention;

Figure 2 is a sectional view taken along the line A-A of Figure 1;

Figure 3 is a plan view of the circuit board according to an embodiment of the present invention;

Figure 4 is a block diagram of one illustrative method shown manufacturing the lamp assembly shown in Figures 1 through 3;

Figure 5 is view in perspective, partly broken away, of a second illustrative embodiment of lamp assembly of the present invention;

Figure 6 is a sectional view taken along the line A-A of Figure 5; and

Figure 7 is a plan view of the circuit board according to the embodiment of Fig. 5.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION OF INVENTION

The following detailed description illustrates the invention by way of example and not by way of limitation. This description will clearly enable one skilled in the art to make and use the invention, and describes several embodiments, adaptations, variations, alternatives and uses of the invention, including what we presently believe is the best mode for carrying out the invention. It will nevertheless be understood that no limitation in the scope of the invention is thereby intended, and that alterations and further modifications of the illustrative devices are contemplated, including but not limited to such further applications of the principles of the invention illustrated herein as would normally occur to one skilled in the art to which this invention relates.

Referring now to Figures 1 and 2, reference numeral 1 indicates one illustrative embodiment of lamp assembly of the present invention. The lamp assembly 1 includes a main body 4, which surrounds a circuit board or card 6, electrical connectors 8, 10, 12, 14 each attached to the board 6 with a nut 15, and a plurality of light emitting diodes (LED) 16 which together comprise a light emitting unit 52.

Referring to Figure 3, the circuit board 6 is of conventional construction. However, it is preferable that the circuit board 6 defines a plurality of apertures 18. The apertures 18 help prevent gas and/or air, generally in the form of bubbles, from being trapped within the material when the uncured lens material is poured

or injected into a mold, as further explained below, thereby the preventing the gas and/or air bubbles from being present within the body 4 when the material cures. Also provided are four electrical connector apertures 22 for attaching the electrical connectors 8, 10, 12 and 14 (8-14) with the nuts 15 to the board 6. However, while the electrical connectors are shown as fasteners attached to the circuit board 6, electrical connectors 8-14 could be wires that extend through the body 4 or a combination of wires and fasteners. Preferably, electrical connector 8 and electrical connector 14 are ground connectors and are larger than connectors 10, 12 so that the entire assembly 1 may be mounted to a structure, such as a vehicle or trailer either as an original equipment assembly or as a replacement assembly for a conventional light. The electrical connector 10 may be a taillight connector, which provides for the LEDs 16 to illuminate at a first, dimmer output level, and electrical connector 12 may be a stop light connector which provides for the LEDs 16 to illuminate at a second, brighter output level. This may be easily accomplished with known methods such as by inserting a resistor in the circuit providing the lower output level. It can be appreciated by one of ordinary skill in the art that only one of electrical connectors 8 and 14 is required to provide an electrical ground and the one of the electrical connectors 10 and 12 may be eliminated to provide for only a single illumination output level. While a male connection is illustrated in Figure 2, those skilled in the art will appreciate that a female or other interconnection form may be employed, if desired. Finally, the circuit board 6 may also comprise reflectors 20 attached to the board 6 to provide for identification of a parked vehicle or trailer implementing the light

assembly 1 of the present invention, for example, when the same is approached by another vehicle at night.

The LEDs 16 preferably are arranged in rows and columns, as best seen in Figures 1 and 3. Various arrangements of the LEDs 16 are compatible with the broader aspects of the invention, and depend to some measure on the shape of the body 4 and/or the intended use of the lamp assembly 1. For example, although a generally rectangular body 4 is shown in the drawings, those skilled in the art will appreciate that other shapes, including round, elliptical, triangular, emblematic and the like may be employed in other embodiments of the invention. The configuration of the body 4 will often determine the arrangement required or permitted of the LEDs 16. Those skilled in the art also will recognize that the LEDs 16 need not be arranged in rows and columns or that a single LED 16 may be employed in other applications of the invention.

The design is unique, for example, because the material used for the body 4 defines both a lens 54 and the body for the lamp assembly 1 to provide a solid one piece assembly. Preferably, the body 4 is constructed from relatively unbreakable material. TENITE cellulosic material available from Eastman Chemical Company is an acceptable material for the lamp assembly 1 of the present invention where the light assembly 1 is intended for use in boat trailers. As indicated above, that material has an impact strength of 4.8 ft-lbs. per sq. inch. In boat trailer applications, the material thickness may approach one half of inch or more, for example, a thickness for which specific manufacture's data was not available from conventional sources. We have tested other material in prototype

assemblies that have sustained 30 ft. lbs. force on the light assembly without damage (tested by dropping a five pound weight from a height of six feet). Again, the preferred material for any particular application is one that does not suffer damage in its intended application during normal or intended operation of that application. In the context of this specification and invention, "unbreakable" has this meaning ascribed to it. The TENITE cellulosic material initially is flowable, and sets up to a final shape over some predetermined period of cure time. The method of cure may vary, depending on the material used to form the body 4. For example, some material may cure in a satisfactory time merely with an ambient air cure. Other materials may require the application of heat or cold to cure satisfactorily. Regardless of cure, however, all embodiments of the invention are designed so that the body 4 encapsulates at least the LEDs 16 and circuit board 6, and are arranged and formed to define the lens 54 for the lamp 1. That encapsulation, in turn, provides at least water resistance properties to the lamp assembly 1, since the material is generally impervious to liquid. If care is taken in the manufacturing process with the electrical connection to the circuit board 6, the lamp assembly 1 easily can be made to be water proof in the conventional sense of that term.

A preferred method of manufacture is shown in Figure 4. A suitable mold 40 is constructed in a conventional method. The mold 40 is designed so that lamp assembly 1 has its intended shape upon removal from the mold. That is to say, the mold 40 is preformed so that the finished lamp assembly 1 may be extracted from the mold directly.

The LEDs are mounted to the circuit board 6 in a step 42. That combined assembly then is placed in the mold 40 in a step 44. As indicated above, preferably the electrical connections 8-14 are attached to the circuit board and inserted in the mold simultaneously with the circuit board and LEDs. However, the electrical connection may be made at a later time, if desired.

In the embodiment illustrated, the mold 40 also has provisions for providing one or more openings 36 through the enclosure. Alternatively, the openings 36 may be formed in the assembly 1 after removal from the mold. Those skilled in the art will recognize that the openings 36 may be eliminated in other embodiments of the invention. In any event, after placement of at least the LEDs and circuit board in the mold 40, the mold is filled with lens material to encapsulate the LEDs and circuit board completely, as illustratively shown in Figure 2. Thereafter, the lens material is cured in a step 48 and the essentially finished product is removed from the mold in a step 50.

In order to manufacture the lamp assembly 1 in high volumes, we have made prototypes through an injection molding process. In using that process, we found that a high number of rejects were obtained because gas and/or air would become trapped within the lens material during the injection molding process. While the problem was not present with all shoots of material, it was prevalent enough to make the process uneconomical for large scale production. We have found that providing apertures 18 through the circuit board 6 helps prevents gas and/or air from being trapped with the body 4 even when a high speed injection molding process is used to form the lamp assembly 1. The apertures 18 location

and number may vary in embodiments of the invention. We have found that the optimal number and location of apertures 18 depends in part on the material used for the body 4, and the speed and, consequently, pressure at which injection takes place. In addition, the construction of the board and the electrical component attachment thereto should be designed so that they do not hinder the flow of material during the injection molding process.

Furthermore, referring to Figs. 5-7, in order to implement high speed manufacturing of the present in invention, it has been found that using circuit boards 6 with extensions 56 extending from the circuit board 6 allows the circuit board 6 to be held in a constant, fixed position when the uncured lens material is injected into the mold. In this manner, the extensions 56 are gripped by the mold or placed in slots defined by the mold to maintain the position of the circuit board 6 within the mold. After the molding process is complete, a portion of the extensions 56 may extend from the cured lens material. Such exposed portions of the extensions 56 are trimmed, filed or allowed to remain.

Because of the ease of manufacture, those skilled in the art will recognize that a number of attributes can be obtained with the lamp assembly 1 of the present invention. Merely by way of example, one or more of the rows 12 of the LEDs 16 may emit a different light spectrum from the remainder of the LEDs 16. Thus, certain of the LEDs 16 may be arranged to provide a yellow arrow indicating a turning motion for the vehicle, while the remaining LEDs 16 emit a light from the red spectrum indicating when the vehicle brakes are applied, for example. Likewise, the material forming the body 4 may have a color pigment

associated with it so that the enclosure 1 has a familiar red brake light configuration, if desired.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results are obtained. As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. Numerous variations, within the scope of the appended claims, will be apparent to those skilled in the art in light of the foregoing description and accompanying drawings. For example, as indicated, the enclosure 1 may assume a variety of shapes. In addition to those described previously, the enclosure 1 may be modified to promote fast curing of the material used for the body 1. Other materials may be employed for the enclosure besides that described. The LED arrangement may vary in other embodiments of this invention. Likewise, the enclosure may be formed in a lens design, if desired. While the light assembly 1 is described as utilizing LEDs, other forms light emitting structures may be employed, if desired. Thus, conventional incandescent lamps or different unconventional sources of light may be employed in embodiments of the invention. LEDs presently are preferred because they offer low energy consumption and long life in applicational use. The light assembly 1 also may be attached to a second structure in a number of ways. Merely by way of example, while conventional threaded fasteners through suitable openings work well, the light assembly 1 may be bracket mounted, surface mounted, or recessed

mounted in a friction fit, if desired. Applications of the light assembly 1 are numerous, and the description with respect to boat trailers is not to be construed in a limiting sense.